Global annual and seasonal variation of CH_4 and CO from SCIAMACHY near-infrared spectra

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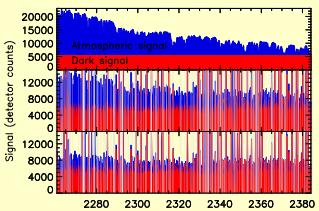
Evergreen

Typical SCIAMACHY near-infrared spectra



Synthetic measurement

SCIAMACHY high surface albedo

SCIAMACHY low surface albedo

grey lines = dead detector pixels

Why measure CH_4 and CO with SCIAMACHY

-CH4 is an active greenhouse gas

-CO is a very important pollution tracer and influences the concentrations of greenhouse gases such as CH4 and CO2

-Their global distributions must be known to a high accuracy in order to understand their impact on atmospheric chemistry and climate change

-The present global coverage of ground-based measurements is insufficient to accurately estimate their distributions, sources, and sinks

-Satellite measurements with their good global and temporal coverage will help to improve our knowledge of these gases

SCIAMACHY[1] measurements of CH_4 and CO

-CH_4 and CO are measured in the near-infrared between 2265 and 2380 nm.

- The SCIAMACHY instrument is stable

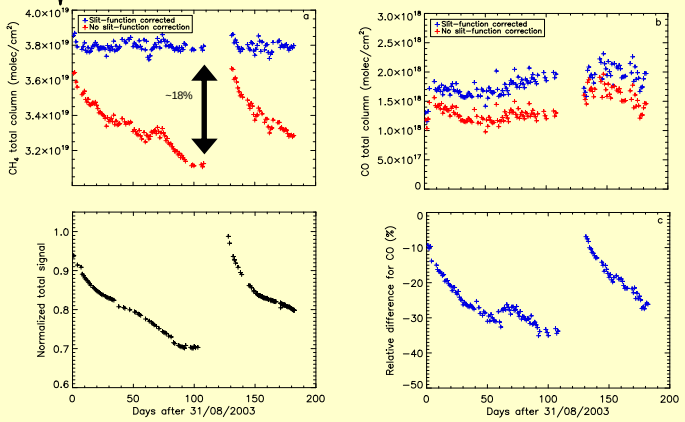
- An ice layer appears to have built up over the near-infrared detectors. This has a significant effect on the retrieved CH4 and CO total column products.

- Careful monitoring of this ice layer has allowed the development of detailed corrections for this ice layer.

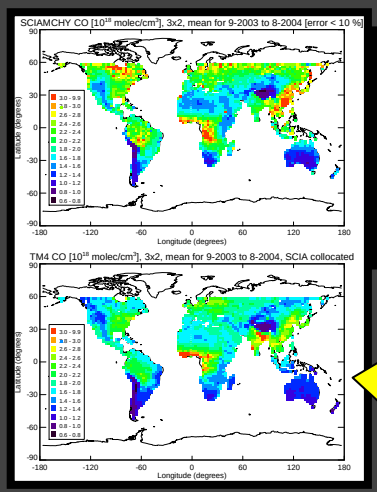
- This results in significant improvement of the accuracy of the retrieved CH4 and CO total columns.

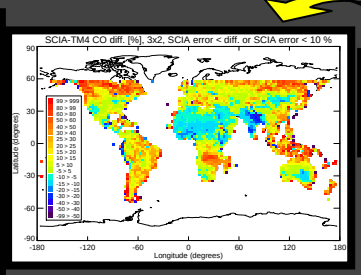
[1] *Scanning Imaging Absorption SpectroMeter for Atmospheric CHartographY*

Retrievals with (blue) and without (red) correction for ice layer compared to loss in total signal due to ice layer



From: Gloudemans et al. 2005, ACP, 5, 2369-2383





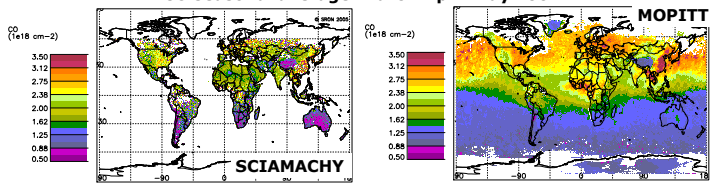
Differences SCIAMACHY – TM4

This figure shows the relative differences between SCIA measured and TM4 modeled CO total column measurements. The model tends to underestimate total columns over northern and tropical latitudes and overestimate CO over the Sahara and southern Asia.

Comparisons SCIAMACHY – MOPITT

This figure shows the comparisons of SCIAMACHY CO total columns and those from the MOPITT instrument on EOS-Terra. Outside source regions there seems to be a bias between SCIAMACH and MOPITT, but the variability is in general good agreement. (The MOPITT data are obtained from NASA LARC).

CO seasonal average: March-April-May 2004



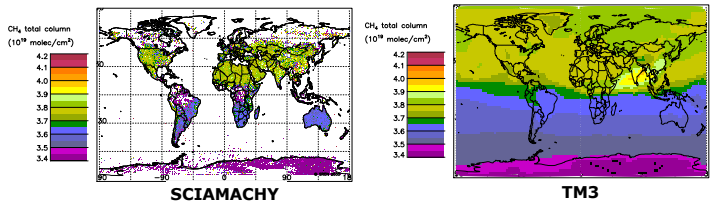
SCIAMACHY and TM4 CO total columns

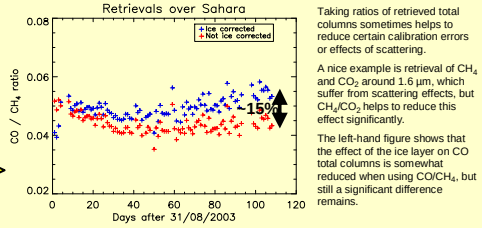
The figure above shows a comparison between SCIAMACHY measured and the chemistry-transport model TM4 simulated CO total column measurements for the period 09-2003 to 08-2004. The SCIAMACHY data have been resampled on the 3°×2° TM4 model resolution. TM4 model results have been sampled for SCIAMACHY collocations. The main features of the annual mean global distribution of modeled and measured CO total columns agree quite well.

SCIAMACHY CO retrievals

- Near-infrared spectral region between 2265 and 2380 nm.
- An ice layer on near-infrared detectors: correction required
- Cloud screening: < 20 % cloud cover within pixel
- Retrieval error (measurement noise) < 1.5 10^{18} molecules cm^{-2}
- Error in annual mean CO < 10 %
- No CO over oceans and high latitude winters (too low albedo)
- High cloud cover further reduces high latitude CO data quality

CH_4 seasonal average: September-October-November 2003





Taking ratios of retrieved total columns sometimes helps to reduce certain calibration errors or effects of scattering.

A nice example is retrieval of CH_4 and CO_2 around 1.6 µm, which suffer from scattering effects, but CH_4/CO_2 helps to reduce this effect significantly.

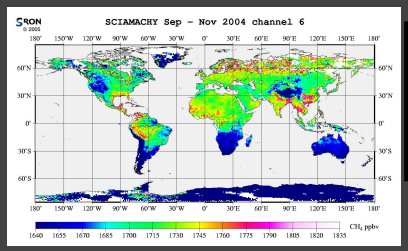
The left-hand figure shows that the effect of the ice layer on CO total columns is somewhat reduced when using CO/CH_4, but still a significant difference remains.

SCIAMACHY and TM3 CH_4 total columns

The figures above and below show a comparison between SCIAMACHY measured and the chemistry-transport model TM3 simulated CH_4 total columns for the periods 09-2003 to 11-2003 and 12-2003 to 02-2004. The SCIAMACHY data have been resampled on 1°×1° grid. The TM3 model simulation are on a 2.5°×2.5° resolution. Both data sets have been normalized to surface pressure. The bottom panels show 5^0 latitudinal averages with 1σ standard deviation as error bars. The main features of the seasonal mean global distribution of modeled and measured total CH_4 columns agree quite well: typically within 3% (blue boxes)

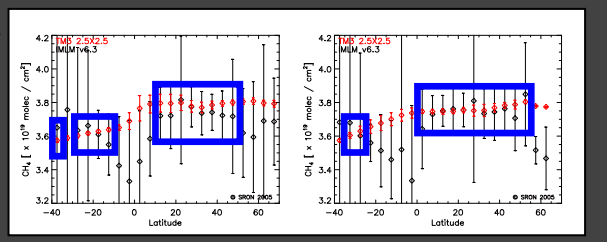
SCIAMACHY CH_4 retrievals using the IMLM retrieval algorithm version 6.3

- Near-infrared spectral region between 2265 and 2380 nm.
- An ice layer on near-infrared detectors: correction required (see figures on the left)
- Cloud screening: only cloud-free measurements are considered
- Retrieval error (measurement noise) < 1.9 10^{18} molecules cm^{-2}
- Few good CH_4 measurements over oceans and high latitude winters (too low albedo)
- High cloud cover further reduces high latitude CH_4 data quality



SCIAMACHY CH_4 retrievals around 1.6 µm

CH_4 total columns can be retrieved from near-infrared spectra around 1.6 and 2.3 µm. The figure on the left shows CH_4 total columns for the period 09-2004 to 11-2004. Here the CH_4/CO_2 ratio, scaled by the global and annual mean CO_2 column-averaged mixing ratio calculated by chemistry transport models, are shown. The ratio has been used to reduce the effect of scattering which is assumed to be similar for both species.



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